

Claims

[c1] WHAT IS CLAIMED

1. A device for acquiring and processing electrical signals produced by a patient's heart, the device comprising:
a plurality of electrodes for attachment to the patient's upper torso, wherein the plurality of electrodes does not include electrodes for attachment to the patient's limbs;
an acquisition module coupled to the plurality of electrodes for acquiring electrical signals from the plurality of electrodes; and
a signal processor coupled to the acquisition module for generating a plurality of electrocardiogram precordial leads from the acquired signals.

[c2] 2. The device of claim 1 and further comprising a belt adapted to be attached around the circumference of the patient's upper torso, and wherein the plurality of electrodes are coupled to the belt so that when the belt is attached to the patient each one of the plurality of electrodes is generally positioned in a plane perpendicular to a longitudinal axis approximately defined by the patient's spine.

[c3] 3. The device of claim 2 wherein the belt is adapted to be attached around the circumference of the patient's upper torso at a level slightly below the patient's breast.

[c4] 4. The device of claim 2 and further comprising a transmitter coupled to the acquisition module and a receiver coupled to an electrocardiogram machine, wherein the transmitter, the acquisition module, and the signal processor are coupled to the belt, wherein the receiver is coupled to the electrocardiogram machine, and wherein the plurality of electrocardiogram precordial leads are wirelessly transmitted from the transmitter to the receiver.

[c5] 5. The device of claim 1 wherein the signal processor generates a plurality of electrocardiogram precordial leads from the acquired electrical signals by generating an approximation of an electrical potential near the center of the patient's heart based on the acquired electrical signals.

[c6] 6. The device of claim 5 wherein the approximation of the electrical potential near the center of the patient's heart is an approximation of Wilson's central terminal.

[c7] 7. The device of claim 5 wherein the signal processor generates an approximation of the electrical potential near the center of the patient's heart by determining a weighted combination of a plurality of the acquired electrical signals.

[c8] 8. The device of claim 1 wherein the plurality of electrodes includes a first electrode attachable to the patient's chest in approximately the fourth intercostal space at the right border of the sternum, a second electrode attachable to the patient's chest in approximately the fifth intercostal space at the anterior axillary line, a third electrode attachable to the patient's back in approximately the fifth intercostal space under the left mid-scapular line, and a fourth electrode attachable to the patient's back in approximately the fifth intercostal space under the right mid-scapular line.

[c9] 9. The device of claim 8 wherein the signal processor generates an approximation of the electrical potential near the center of the patient's heart by determining a weighted combination of the signals acquired from the plurality of electrodes.

[c10] 10. The device of claim 9 wherein the signal processor generates each one of the plurality of electrocardiogram precordial leads by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the first electrode and the second electrode.

[c11] 11. The device of claim 1 wherein the plurality of electrodes includes a first electrode attachable to the patient's back in approximately the fifth intercostal space under the right mid-scapular line and at least one electrode attachable to the patient's chest.

[c12] 12. The device of claim 11 wherein the signal processor uses the signal

acquired from the first electrode as an approximation of the electrical potential near the center of the patient's heart.

[c13] 13. The device of claim 12 wherein the signal processor generates each one of the plurality of electrocardiogram precordial leads by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the at least one electrode on the patient's chest.

[c14] 14. The device of claim 1 wherein the acquisition module is capable of storing precordial leads for approximately one month.

[c15] 15. The device of claim 1 and further comprising an electrocardiogram machine wirelessly coupled to the acquisition module and a telemetry monitor coupled to the electrocardiogram machine.

[c16] 16. An electrocardiogram device for acquiring and processing electrical signals produced by a patient's heart, the device comprising:
a belt adapted to be attached to the patient's upper torso;
a plurality of electrodes coupled to the belt, wherein the plurality of electrodes does not include electrodes for attachment to the patient's limbs;
an acquisition module coupled to the belt and the plurality of electrodes for acquiring electrical signals from the plurality of electrodes;
a signal processor coupled to the acquisition module for generating a plurality of electrocardiogram precordial leads from the acquired electrical signals;
a transmitter coupled to the acquisition module for transmitting the plurality of electrocardiogram precordial leads; and
a receiver wirelessly coupled to the transmitter for receiving the acquired electrical signals.

[c17] 17. The device of claim 16 wherein the plurality of electrodes are coupled to the belt so that when the belt is attached to the patient each one of the plurality of electrodes is generally positioned in a plane perpendicular to a

longitudinal axis approximately defined by the patient's spine.

[c18] 18. The device of claim 17 wherein the belt is adapted to be attached around the circumference of the patient's upper torso at a level slightly below the patient's breast.

[c19] 19. The device of claim 16 wherein the signal processor generates a plurality of electrocardiogram precordial leads from the acquired electrical signals by generating an approximation of an electrical potential near the center of the patient's heart based on the acquired electrical signals.

[c20] 20. The device of claim 19 wherein the approximation of the electrical potential near the center of the patient's heart is an approximation of Wilson's central terminal.

[c21] 21. The device of claim 19 wherein the signal processor generates an approximation of the electrical potential near the center of the patient's heart by determining a weighted combination of a plurality of the acquired electrical signals.

[c22] 22. The device of claim 16 wherein the plurality of electrodes includes a first electrode positionable on the patient's chest in approximately the fourth intercostal space at the right border of the sternum, a second electrode positionable on the patient's chest in approximately the fifth intercostal space at the anterior axillary line, a third electrode positionable on the patient's back in approximately the fifth intercostal space under the left mid-scapular line, and a fourth electrode positionable on the patient's back in approximately the fifth intercostal space under the right mid-scapular line.

[c23] 23. The device of claim 22 wherein the signal processor generates an approximation of the electrical potential near the center of the patient's heart by determining a weighted combination of the signals acquired from the plurality of electrodes.

[c24] 24. The device of claim 23 wherein the signal processor generates each one

of the plurality of electrocardiogram precordial leads by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the first electrode and the second electrode.

[c25] 25. The device of claim 16 wherein the plurality of electrodes includes a first electrode positionable on the patient's back in approximately the fifth intercostal space under the right mid-scapular line and at least one electrode positionable on the patient's chest.

[c26] 26. The device of claim 25 wherein the signal processor uses the signal acquired from the first electrode as an approximation of the electrical potential near the center of the patient's heart.

[c27] 27. The device of claim 26 wherein the signal processor generates each one of the plurality of electrocardiogram precordial leads by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the at least one electrode on the patient's chest.

[c28] 28. The device of claim 16 wherein the acquisition module is capable of storing precordial leads for approximately one month.

[c29] 29. The device of claim 16 and further comprising an electrocardiogram machine wirelessly coupled to the acquisition module and a telemetry monitor coupled to the electrocardiogram machine.

[c30] 30. An acquisition device for attachment to a patient and for acquiring electrical signals produced by the patient's heart, the device comprising:
a belt adapted to be attached to the patient's upper torso;
a plurality of electrodes coupled to the belt, the plurality of electrodes including at least one electrode positioned within the belt so that when the belt is attached to the patient the electrode contacts the patient's chest, and at least one electrode positioned within the belt so that when the belt is attached to the patient the electrode contacts the patient's back, wherein the

plurality of electrodes does not include electrodes for attachment to the patient's limbs;
an acquisition module including a signal processor coupled to the belt and the plurality of electrodes for acquiring electrical signals from the plurality of electrodes and for generating a plurality of electrocardiogram precordial leads from the acquired signals; and
a transmitter coupled to the acquisition module for transmitting the plurality of electrocardiogram precordial leads to a remote location.

- [c31] 31. The device of claim 30 wherein the plurality of electrodes are coupled to the belt so that when the belt is attached to the patient each one of the plurality of electrodes is generally positioned in a plane perpendicular to a longitudinal axis approximately defined by the patient's spine.
- [c32] 32. The device of claim 30 wherein the belt is attachable around the circumference of the patient's upper torso at a level slightly below the patient's breast.
- [c33] 33. The device of claim 30 and further comprising a receiver located at the remote location, wherein the acquired signals are wirelessly transmitted from the transmitter to the receiver.
- [c34] 34. The device of claim 30 wherein the signal processor generates a plurality of electrocardiogram precordial leads from the acquired electrical signals by generating an approximation of an electrical potential near the center of the patient's heart based on the acquired electrical signals.
- [c35] 35. The device of claim 34 wherein the approximation of the electrical potential near the center of the patient's heart is an approximation of Wilson's central terminal.
- [c36] 36. The device of claim 34 wherein the signal processor generates an approximation of the electrical potential near the center of the patient's heart by determining a weighted combination of a plurality of the acquired electrical signals.

[c37] 37. The device of claim 30 wherein the plurality of electrodes includes a first electrode positionable on the patient's chest in approximately the fourth intercostal space at the right border of the sternum, a second electrode positionable on the patient's chest in approximately the fifth intercostal space at the anterior axillary line, a third electrode positionable on the patient's back in approximately the fifth intercostal space under the left mid-scapular line, and a fourth electrode positionable on the patient's back in approximately the fifth intercostal space under the right mid-scapular line.

[c38] 38. The device of claim 37 wherein the signal processor generates an approximation of the electrical potential near the center of the patient's heart by determining a weighted combination of the signals acquired from the plurality of electrodes.

[c39] 39. The device of claim 38 wherein the signal processor generates each one of the plurality of electrocardiogram precordial leads by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the first electrode and the second electrode.

[c40] 40. The device of claim 30 wherein the plurality of electrodes includes a first electrode positionable on the patient's back in approximately the fifth intercostal space under the right mid-scapular line and at least one electrode positionable on the patient's chest.

[c41] 41. The device of claim 40 wherein the signal processor uses the signal acquired from the first electrode as an approximation of the electrical potential near the center of the patient's heart.

[c42] 42. The device of claim 41 wherein the signal processor generates each one of the plurality of electrocardiogram precordial leads by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the at least one electrode on the patient's chest.

- [c43] 43. The device of claim 30 wherein the acquisition module is capable of storing precordial leads for approximately one month.
- [c44] 44. The device of claim 30 and further comprising an electrocardiogram machine wirelessly coupled to the acquisition module and a telemetry monitor coupled to the electrocardiogram machine.
- [c45] 45. A method of acquiring and processing electrical signals produced by a patient's heart, the method comprising the acts of:
positioning a plurality of electrodes on the patient's upper torso, without positioning electrodes on the patient's limbs;
acquiring electrical signals from the plurality of electrodes; and
generating a plurality of electrocardiogram precordial leads from the acquired electrical signals.
- [c46] 46. The method of claim 45 wherein the plurality of electrodes are coupled to a belt and wherein the act of positioning a plurality of electrodes on the patient's upper torso includes the act of wrapping the belt around the circumference of the patient's upper torso so that each one of the plurality of electrodes is generally positioned in a plane perpendicular to a longitudinal axis approximately defined by the patient's spine.
- [c47] 47. The method of claim 46 wherein the act of wrapping a belt around circumference of the patient's upper torso includes the act of wrapping a belt around the circumference of the patient's upper torso at a level slightly below the patient's breast.
- [c48] 48. The method of claim 46 and further comprising the act of wirelessly transmitting the plurality of electrocardiogram precordial leads from a transmitter coupled to the belt to a receiver located in a remote location.
- [c49] 49. The method of claim 45 wherein the act of generating a plurality of electrocardiogram precordial leads from the acquired electrical signals includes the act of generating an approximation of an electrical potential near the center of the patient's heart based on the acquired electrical signals.

[c50] 50. The method of claim 49 wherein the act of generating an approximation of an electrical potential near the center of the patient's heart based on the acquired electrical signals includes the act of generating an approximation of Wilson's central terminal.

[c51] 51. The method of claim 49 wherein the act of generating an approximation of the electrical potential near the center of the patient's heart includes the act of determining a weighted combination of a plurality of the acquired electrical signals.

[c52] 52. The method of claim 45 wherein the act of positioning a plurality of electrodes on the patient's upper torso includes the act of positioning a first electrode on the patient's chest in approximately the fourth intercostal space at the right border of the sternum, a second electrode on the patient's chest in approximately the fifth intercostal space at the anterior axillary line, a third electrode on the patient's back in approximately the fifth intercostal space under the left mid-scapular line, and a fourth electrode on the patient's back in approximately the fifth intercostal space under the right mid-scapular line.

[c53] 53. The method of claim 52 wherein the act of generating an approximation of the electrical potential near the center of the patient's heart includes the act of determining a weighted combination of the signals acquired from the plurality of electrodes.

[c54] 54. The method of claim 53 wherein the act of generating a plurality of electrocardiogram precordial leads from the acquired electrical signals includes the act of generating each one of the plurality of electrocardiogram precordial leads by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the first electrode and the second electrode.

[c55] 55. The method of claim 45 wherein the act of positioning a plurality of electrodes on the patient's upper torso includes the act of positioning a first

electrode in approximately the fifth intercostal space under the right mid-scapular line and at least one electrode on the patient's chest.

[c56] 56. The method of claim 55 wherein the act of generating an approximation of the electrical potential near the center of the patient's heart includes the act of using the signal acquired from the first electrode as an approximation of the electrical potential near the center of the patient's heart.

[c57] 57. The method of claim 56 wherein the act of generating a plurality of electrocardiogram precordial leads from the acquired electrical signals includes the act of generating each one of the plurality of electrocardiogram precordial leads by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the at least one electrode on the patient's chest.

[c58] 58. The method of claim 45 wherein the act of acquiring electrical signals from the plurality of electrodes includes the act of acquiring electrical signals for approximately one month.

[c59] 59. The method of claim 45 and further comprising the act of wirelessly coupling a telemetry monitor to the plurality of electrodes.

[c60] 60. A method of acquiring and processing electrical signals produced by a patient's heart, the method comprising the acts of:
positioning a plurality of electrodes on the patient's upper torso, the plurality of electrodes including at least one electrode positionable on the patient's chest and at least one electrode positionable on the patient's back, wherein the plurality of electrodes does not include electrodes for positioning on the patient's limbs;
acquiring electrical signals from the plurality of electrodes;
generating an approximation of an electrical potential near the center of the patient's heart by determining a weighted combination of a plurality of the acquired electrical signals; and
generating a plurality of electrocardiogram precordial leads from the

acquired electrical signals by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the at least one electrode on the patient's chest.

[c61] 61. The method of claim 60 wherein the plurality of electrodes are coupled to a belt and wherein the act of positioning a plurality of electrodes on the patient's upper torso includes the act of wrapping the belt around the circumference of the patient's upper torso so that each one of the plurality of electrodes is generally positioned in a plane perpendicular to a longitudinal axis approximately defined by the patient's spine.

[c62] 62. The method of claim 61 wherein the act of wrapping a belt around the circumference of the patient's upper torso includes the act of wrapping a belt around the circumference of the patient's upper torso at a level slightly below the patient's breast.

[c63] 63. The method of claim 61 and further comprising the act of wirelessly transmitting the plurality of electrocardiogram precordial leads from a transmitter coupled to the belt to a receiver.

[c64] 64. The method of claim 60 wherein the act of generating an approximation of an electrical potential near the center of the patient's heart based on the acquired electrical signals includes the act of generating an approximation of Wilson's central terminal.

[c65] 65. The method of claim 60 wherein the act of positioning a plurality of electrodes on the patient's upper torso includes the act of positioning a first electrode on the patient's chest in approximately the fourth intercostal space at the right border of the sternum, a second electrode on the patient's chest in approximately the fifth intercostal space at the anterior axillary line, a third electrode on the patient's back in approximately the fifth intercostal space under the left mid-scapular line, and a fourth electrode on the patient's back in approximately the fifth intercostal space under the right mid-scapular line.

- [c66] 66. The method of claim 65 wherein the act of generating an approximation of the electrical potential near the center of the patient's heart includes the act of determining a weighted combination of the signals acquired from the plurality of electrodes.
- [c67] 67. The method of claim 66 wherein the act of generating a plurality of electrocardiogram precordial leads from the acquired electrical signals includes the act of generating each one of the plurality of electrocardiogram precordial leads by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the first electrode and the second electrode.
- [c68] 68. The method of claim 60 wherein the act of positioning a plurality of electrodes on the patient's upper torso includes the act of positioning a first electrode in approximately the fifth intercostal space under the right mid-scapular line and at least one electrode on the patient's chest.
- [c69] 69. The method of claim 68 wherein the act of generating an approximation of the electrical potential near the center of the patient's heart includes the act of using the signal acquired from the first electrode as an approximation of the electrical potential near the center of the patient's heart.
- [c70] 70. The method of claim 69 wherein the act of generating a plurality of electrocardiogram precordial leads from the acquired electrical signals includes the act of generating each one of the plurality of electrocardiogram precordial leads by subtracting the approximation of the electrical potential near the center of the patient's heart from each one of the signals acquired from the at least one electrode on the patient's chest.
- [c71] 71. The method of claim 60 wherein the act of acquiring electrical signals from the plurality of electrodes includes the act of acquiring electrical signals for approximately one month.
- [c72] 72. The method of claim 60 and further comprising the act of wirelessly coupling a telemetry monitor to the plurality of electrodes.